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DESIGN AND PARAMETRIC ANALYSIS OF TRIANGULAR MICROSTRIP ANTENNA LOADED WITH DIELECTRIC SUPERSTRATE

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ABSTRACT

In this paper, the effect of a dielectric superstrate on the gain and resonant frequency of a triangular microstrip antenna has been studied. The proper choice of thickness of superstrate and superstrate layer result insignificant improvement in gain. The improvement in reflection coefficient is also shown. The results obtained shows a shift in resonant frequency by introducing the superstrate of suitable thickness and material.

Keywords:* *Antenna, Resonant Frequency, Triangular Microstip Antenna, Superstrate.

I. INTRODUCTION

The attractive features of mirostrip antennas [1] such as light weight, low profile, manufacturing ease and compatibility with integrated circuit technology have recently demanded greater investigation of their performance and applications. However mirostrip antennas have narrow bandwidth and can only operate effectively in vicinity of resonant frequency which limit its wider application. Large numbers of investigations have been conducted on triangular patch microstrip antenna which shows the remarkable advantages of equilateral triangular geometry[2].The dielectric superstrate loaded equilateral triangular patch antenna using spectral domain technique has been studied[3]. Dahele and Lee[4] concluded that if the side length of the triangular patch is replaced by its effective value while leaving the relative permittivity unchanged, good agreement between theory and experiment is obtained. Garg and Long[5] also arrived at the same results.

This paper represents the experimental and theoretical study of triangular microstirp patch antenna with dielectric superstrate and how loading are used to accurately estimate the effect of a superstrate on gain parameter and resonant frequencies. The computed results for different radome dimensions are compared with the experimental values.

II. THEORETICAL FORMULAS

As per the cavity model analysis by Helszajn[6], the general formula for the resonant frequencies of TM_{mn} modes obtained for triangular patch antenna can be given as

$$f_{mn} = \frac{2c}{3a\epsilon^{1/2}}(m^2 + mn + n^2)^{1/2} \qquad (1)$$

There are two suggestions for accounting for nonperfect magnetic wall effects. The sidelength *a* should be replaced by the effective value

$$a_e = a + h(\epsilon_r)^{-1/2} \tag{2}$$

BB[7] proposed that alongwith the effective value of a_e , effective value of ϵ_r should be replaced as

$$\epsilon_e = \frac{(\epsilon_r + 1)}{2} + \frac{(\epsilon_r - 1)}{2}\left(1 + \frac{12h}{a}\right)^{-1/2} \tag{3}$$

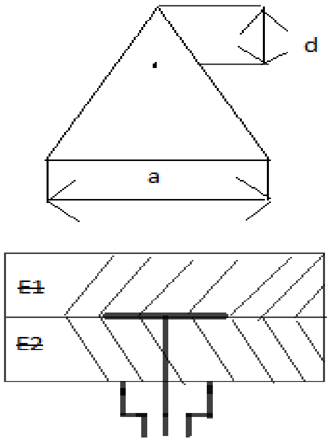


Fig. 1. Superstrate loaded triangular patch antenna

Although in the cavity modal of the equilateral triangular patch, the sidelength *a* will be replaced by its effective value a_e but ϵ_r should not be replaced ϵ_e .

2.1 Input Impedance of coaxial fed Antenna

The input impedance of coaxial fed antenna where the feed point is located at a distance *d* from vertex of antenna is given as

$$Z = R + jX \qquad = -j\omega\mu \sum_{n=0}^{\infty}\sum_{m=n}^{\infty} \frac{4\sqrt{3}\,h\,C_{mn}^{*}}{27a^2} * \begin{bmatrix} \cos\left(\frac{2\pi l d}{\sqrt{3}a}\right) j_0\left(\frac{\pi l w}{\sqrt{3}a}\right) \\ + \cos\left(\frac{2\pi m d}{\sqrt{3}a}\right) j_0\left(\frac{\pi m w}{\sqrt{3}a}\right) \\ + \cos\left(\frac{2\pi n d}{\sqrt{3}a}\right) j_0\left(\frac{\pi n w}{\sqrt{3}a}\right) \end{bmatrix}^2 * \left[\frac{(\omega^2 - \omega_r^2)\mu_0\epsilon + j\delta_{eff}k^2}{(\omega^2 - \omega_r^2)^2\mu_0^2\epsilon^2 + \delta_{eff}^2 k^4} \tag{4}$$

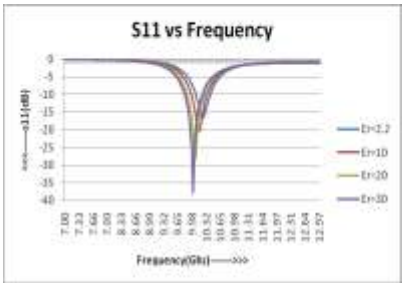
Where δ_{eff} is effective loss tangent .If the frequency is adjusted such that the loss of surface wave is negligible then it is given by

$$\delta_{eff} = \frac{P_r + P_d + P_c}{2\omega W_E} \tag{5}$$

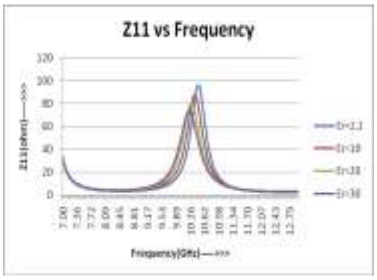
Where P_r, P_d and P_c are the radiation, dielectric and copper losses respectively and $2W_E$ is energy stored in cavity.

III. RESULTS

(1) S_{11} Vs frequency

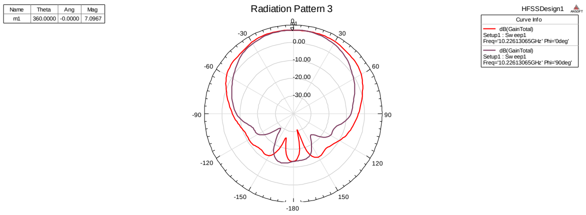


(2) Z_{11} Vs frequency

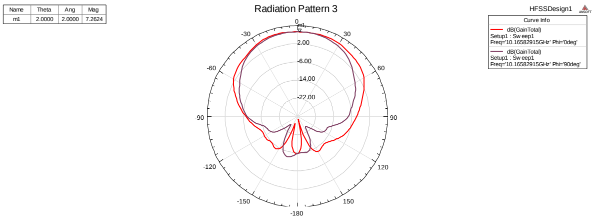


(3) Gain

(i)



(ii)



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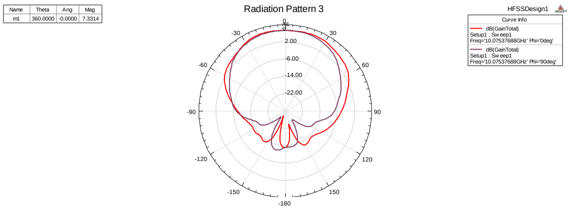

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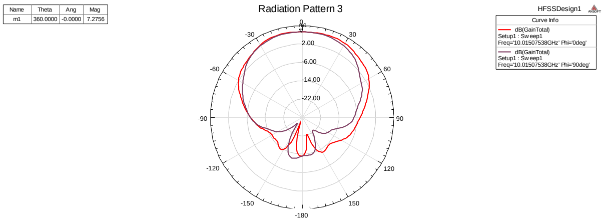

Figure 2: (i) $\epsilon_{r=2.2}$, (ii) $\epsilon_{r=10}$, (iii) $\epsilon_{r=20}$, (iv) $\epsilon_{r=30}$.

Dielectric constant of superstate	Frequency at dominant mode (GHz)	Impedance (ohm)	Gain (dB)
2.2	10.2261	47.9622	7.0967
10	10.1658	53.9147	7.2624
20	10.0754	52.3388	7.3314
30	10.0151	49.6417	7.2756

Table 1: Performance parameter of Triangular Patch Antenna

IV. CONCLUSION AND DISCUSSION

In conclusion the variation of the gain with superstrates of different dielectric constant have been shown. These results appear to informative during the implementation and design of the microstrip antenna. It is found that as the permittivity of material increases, compactness increases.

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